Scopus

Documents

Tan, C.[a b] , Selamat, J.[a c] , Jambari, N.N.[a c] , Sukor, R.[a c] , Murugesu, S.[a] , Khatib, A.[d]

Muscle and serum metabolomics for different chicken breeds under commercial conditions by GC–MS
(2021) *Foods*, 10 (9), art. no. 2174, .

DOI: 10.3390/foods10092174

[a] Food Safety and Food Integrity (FOSFI), Institute of Tropical Agriculture and Food Security, Universiti Putra Malaysia (UPM), Serdang, Selangor, 43400, Malaysia
[b] National Public Health Laboratory, Ministry of Health Malaysia, Lot 1853, Kampung Melayu Sungai Buloh, Sungai Buloh, Selangor, 47000, Malaysia
[c] Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia (UPM), Serdang, Selangor, 43400, Malaysia
[d] Department of Pharmaceutical Chemistry, Faculty of Pharmacy, International Islamic University Malaysia, Kuantan, Pahang, 25200, Malaysia

Abstract
Globally, village chicken is popular and is known as a premium meat with a higher price. Food fraud can occur by selling other chicken breeds at a premium price in local markets. This study aimed to distinguish local village chicken from other chicken breeds available in the market, namely, colored broiler (Hubbard), broiler (Cobb), and spent laying hen (Dekalb) in pectoralis major and serum under commercial conditions using an untargeted metabolomics approach. Both pectoralis major and serum were analyzed using gas chromatography–mass spectrometry (GC–MS). The principal component analysis (PCA) results distinguished four different chicken breeds into three main groups for pectoralis major and serum. A total of 30 and 40 characteristic metabolites were identified for pectoralis major and serum, respectively. The four chicken breeds were characterized by the abundance of metabolites such as amino acids (L−glutamic acid, L−threonine, L−serine, L−leucine), organic acids (L−lactic acid, succinic acid, 3−hydroxybutyric acid), sugars (D−allose, D−glucose), sugar alcohols (myo−inositol), and fatty acids (linoleic acid). Our results suggest that an untargeted metabolomics approach using GC–MS and PCA could discriminate chicken breeds for pectoralis major and serum under commercial conditions. In this study, village chicken could only be distinguished from colored broiler (Hubbard) by serum samples. © 2021 by the authors. Licensee MDPI, Basel, Switzerland.

Author Keywords
Biomarkers; Chicken; GC–MS; Metabolomics; PCA; Pectoralis major; Serum

References

- Semwogerere, F., Neethling, J., Muchenje, V., Hoffman, L.C.
Meat Quality, Fatty Acid Profile, and Sensory Attributes of Spent Laying Hens Fed Expeller Press Canola Meal or a Conventional Diet
(2019) *Poult. Sci*, 98, pp. 3557-3570.
[CrossRef] [PubMed]

- Petracci, M., Bianchi, M., Mudalal, S., Cavani, C.
Functional Ingredients for Poultry Meat Products
(2013) *Trends Food Sci. Technol*, 33, pp. 27-39.
[CrossRef]

- Feng, Y., Cai, Y., Fu, X., Zheng, L., Xiao, Z., Zhao, M.
Comparison of Aroma-Active Compounds in Broiler Broth and Native Chicken Broth by Aroma Extract Dilution Analysis (AEDA), Odor Activity Value (OAV) and Omission Experiment
(2018) *Food Chem*, 265, pp. 274-280.
[CrossRef] [PubMed]

- Mohd Shahmi Hakimi, M., Alias, Z., Wan Khadijah, W.E., Abdullah, R.B., Rahman, M.M.
Effect of Diet Containing Palm Kernel Cake and Coconut Meal Cake on Growth Performance and Carcass Quality of Free-Range Chicken in Malaysia (Kesan Daripada Diet Yang Mengandungi Isirung Kernal Sawit Dan Isirung Kelapa Pada
(2019) *Sains Malays*, 48, pp. 991-998.
[CrossRef]

- Azahan, E.A.E.
The Red and Black-Red Native Chickens of Malaysia
(1994) *Malays. Agric. Res. Dev. Inst. Res. J*, 22, pp. 73-78.

- Aini, I.
Indigenous Chicken Production in South-East Asia
(1990) *Worlds Poult. Sci. J*, 46, pp. 51-57.
[CrossRef]

- *The Star*,
(accessed on 10 May 2021)

- Malay Mail. (accessed on 10 May 2021)

- Fontanesi, L.
Meat Authenticity and Tracebility
(2017) *Lawrie's Meat Science*, pp. 585-633.
Woodhead Publishing: Cambridge, UK, [CrossRef]

- Fiehn, O.
Metabolomics—The Link between Genotypes and Phenotypes
(2002) *Funct. Genom*, 48, pp. 155-171.
[CrossRef]

- Cevallos-Cevallos, J.M., Reyes-De-Corcuera, J.I., Etxeberria, E., Danyluk, M.D., Rodrick, G.E.
Metabolomic Analysis in Food Science: A Review
(2009) *Trends Food Sci. Technol*, 20, pp. 557-566.
[CrossRef]

- Caboni, P., Maxia, D., Scano, P., Addis, M., Dedola, A., Pes, M., Murgia, A., Pirisi, A.
A Gas Chromatography-Mass Spectrometry Untargeted Metabolomics Approach to Discriminate Fiore Sardo Cheese Produced from Raw or Thermized Ovine Milk
(2019) *J. Dairy Sci*, 102, pp. 5005-5018.
[CrossRef]

- Man, K.Y., Chan, C.O., Tang, H.H., Dong, N.-P., Capozzi, F., Wong, K.H., Kwok, K.W.H., Mok, D.K.W.
Mass Spectrometry-Based Untargeted Metabolomics Approach for Differentiation of Beef of Different Geographic Origins
(2021) *Food Chem*, 338, p. 127847.
[CrossRef] [PubMed]

- Ueda, S., Iwamoto, E., Kato, Y., Shinohara, M., Shirai, Y., Yamanoue, M.
Comparative Metabolomics of Japanese Black Cattle Beef and Other Meats Using Gas Chromatography–Mass Spectrometry

(2018) *Biosci. Biotechnol. Biochem*, 83, pp. 137-147.
[CrossRef]

- Surowiec, I., Fraser, P.D., Patel, R., Halket, J., Bramley, P.M.
Metabolomic Approach for the Detection of Mechanically Recovered Meat in Food Products
(2011) *Food Chem*, 125, pp. 1468-1475.
[CrossRef]

- Mabuchi, R., Adachi, M., Kikutani, H., Tanimoto, S.
Discriminant Analysis of Muscle Tissue Type in Yellowtail Seriola Quinquera-diata Muscle Based on Metabolic Component Profiles
(2018) *Food Sci. Technol. Res*, 24, pp. 883-891.
[CrossRef]

- Rochfort, S.J., Ezernieks, V., Maher, A.D., Ingram, B.A., Olsen, L.
Mussel Metabolomics—Species Discrimination and Provenance Determination
(2013) *Food Res. Int*, 54, pp. 1302-1312.
[CrossRef]

- Beauclercq, S., Nadal-Desbarats, L., Hennequet-Antier, C., Collin, A., Tesseraud, S., Bourin, M., Le Bihan-Duval, E., Berri, C.
Serum and Muscle Metabolomics for the Prediction of Ultimate PH, a Key Factor for Chicken-Meat Quality
(2016) *J. Proteome Res*, 15, pp. 1168-1178.
[CrossRef]

- Mabuchi, R., Ishimaru, A., Tanaka, M., Kawaguchi, O., Tanimoto, S.
Metabolic Profiling of Fish Meat by Gc-Ms Analysis, and Correlations with Taste Attributes Obtained Using an Electronic Tongue
(2019) *Metabolites*, 9, p. 1.
[CrossRef]

- Trimigno, A., Münger, L., Picone, G., Freiburghaus, C., Pimentel, G., Vionnet, N., Pralong, F., Vergères, G.
GC-MS Based Metabolomics and NMR Spectroscopy Investigation of Food Intake Biomarkers for Milk and Cheese in Serum of Healthy Humans
(2018) *Metabolites*, 8, p. 26.
[CrossRef] [PubMed]

- Mykhailenko, O., Ivanauskas, L., Bezruk, I., Lesyk, R., Georgiyants, V.
Comparative Investigation of Amino Acids Content in the Dry Extracts of Juno Bucharica, Gladiolus Hybrid Zefir, Iris Hungarica, Iris Variegata and Crocus Sativus Raw Materials of Ukrainian Flora
(2020) *Sci. Pharm*, 88, p. 8.
[CrossRef]

- Grabež, V., Bjelanović, M., Rohloff, J., Martinović, A., Berg, P., Tomović, V., Rogić, B., Egelandsdal, B.
The Relationship between Volatile Compounds, Metabolites and Sensory Attributes: A Case Study Using Lamb and Sheep Meat
(2019) *Small Rumin. Res*, 181, pp. 12-20.
[CrossRef]

- Shi, Y., Li, X., Huang, A.
  A Metabolomics-Based Approach Investigates Volatile Flavor Formation and Characteristic Compounds of the Dahe Black Pig Dry-Cured Ham
  (2019) *Meat Sci*, 158, p. 107904.
  [CrossRef]

- Murugesu, S., Ibrahim, Z., Ahmed, Q.U., Yusoff, N.I.N., Uzir, B.F., Perumal, V., Abas, F., Khatib, A.
  Characterization of α-Glucosidase Inhibitors from Clinacanthus Nutans Lindau Leaves by Gas Chromatography-Mass Spectrometry-Based Metabolomics and Molecular Docking Simulation
  (2018) *Molecules*, 23, p. 2402.
  [CrossRef] [PubMed]

- Shi, S., Yi, L., Yun, Y., Zhang, X., Liang, Y.
  A Combination of GC-MS and Chemometrics Reveals Metabolic Differences between Serum and Plasma
  (2015) *Anal. Methods*, 7, pp. 1751-1757.
  [CrossRef]

- Yamada, T., Kamiya, M., Higuchi, M.
  Gas Chromatography–Mass Spectrometry-based Metabolomic Analysis of Wagyu and Holstein Beef
  (2020) *Metabolites*, 10, p. 95.
  [CrossRef]

- Eriksson, L., Byrne, T., Johansson, E., Trygg, J., Vikstrom, C.
  (2006) *Multi-and Megavariate Data Analysis Basic Principles and Applications*, pp. 33-53. 2nd ed.; Umetrics Academy: Umeå, Sweden

- Guntarti, A., Ningrum, K.P., Gandjar, I.G., Salamah, N.
  Authentication of Sprague Dawley Rats (Rattus Norvegicus) Fat with GC-MS (Gas Chromatography-Mass Spectrometry) Combined with Chemometrics
  (2021) *Int. J. Appl. Pharm*, 13, pp. 134-139.
  [CrossRef]

- Ivanne, C., Roy, L., John, L., Roberto, M., La, M., John, M., Sandrine, W., Claus, P.
  NMR-Based Metabolic Characterization of Chicken Tissues and Biofluids: A Model for Avian Research
  (2016) *Metabolomics*, 12, pp. 1-14.
  [CrossRef]

- Mueller, S., Taddei, L., Albiker, D., Kreuzer, M., Siegrist, M., Messikommer, R.E., Gangnat, I.D.M.
  Growth, Carcass, and Meat Quality of 2 Dual-Purpose Chickens and a Layer Hybrid Grown for 67 or 84 D Compared with Slow-Growing Broilers
  (2020) *J. Appl. Poult. Res*, 29, pp. 185-196.
  [CrossRef]

- Xiao, Z., Ge, C., Zhou, G., Zhang, W., Liao, G.
  1H NMR-Based Metabolic Characterization of Chinese Wuding Chicken Meat
  (2019) *Food Chem*, 274, pp. 574-582.
  [CrossRef]

- **Scientific Opinion on the Safety and Efficacy of AviMatrix®(Benzoic Acid, Calcium Formate and Fumaric Acid) for Chickens for Fattening, Chickens Reared for Laying, Minor Avian Species for Fattening and Minor Avian Species Reared to Point of Lay**
(2015) *EFSA J*, 13, p. 3794.
Panel on Additives and Products or Substances used in Animal Feed EFSA. [CrossRef]

- Peng, M.L., Han, J., Li, L.L., Ma, H.T.
Metabolomics Reveals the Mechanism of (-)-Hydroxycitric Acid Promotion of Protein Synthesis and Inhibition of Fatty Acid Synthesis in Broiler Chickens
(2018) *Animal*, 12, pp. 774-783.
[CrossRef]

- Donsbough, A.L., Powell, S., Waguespack, A., Bidner, T.D., Southern, L.L.
Uric Acid, Urea, and Ammonia Concentrations in Serum and Uric Acid Concentration in Excreta as Indicators of Amino Acid Utilization in Diets for Broilers
(2010) *Poult. Sci*, 89, pp. 287-294.
[CrossRef]

- Kong, Y., Yang, X., Ding, Q., Zhang, Y.Y., Sun, B.G., Chen, H.T., Sun, Y.
Comparison of Non-Volatile Umami Components in Chicken Soup and Chicken Enzymatic Hydrolysate
(2017) *Food Res. Int*, 102, pp. 559-566.
[CrossRef] [PubMed]

- Zotte, A.D., Gleeson, E., Franco, D., Cullere, M., Lorenzo, M.
Proximate Composition, Amino Acid Profile, and Oxidative Stability of Slow-Growing Indigenous Chickens Compared with Commercial Broiler Chickens
(2020) *Foods*, 9, p. 546.
[CrossRef]

- Wu, G., Bazer, F.W., Burghardt, R.C., Johnson, G.A., Kim, S.W., Knabe, D.A., Li, P., Satterfield, M.C.
Proline and Hydroxyproline Metabolism: Implications for Animal and Human Nutrition
(2011) *Amino Acids*, 40, pp. 1053-1063.
[CrossRef]

- Lengkidworraphiphat, P., Wongpoomchai, R., Bunmee, T., Chariyakornkul, A., Chaiwang, N., Jaturasitha, S.
Taste-Active and Nutritional Components of Thai Native Chicken Meat: A Perspective of Consumer Satisfaction
(2021) *Food Sci. Anim. Resour*, 41, pp. 237-246.
[CrossRef] [PubMed]

- Okarini, I.A., Purnomo, H., Aulanni'am, Radiati, L.E.
Proximate, Total Phenolic, Antioxidant Activity and Amino Acids Profile of Bali Indigenous Chicken, Spent Laying Hen and Broiler Breast Fillet
(2013) *Int. J. Poult. Sci*, 12, pp. 415-420.
[CrossRef]

- Kidd, M.T., Poernama, F., Wibowo, T., Maynard, C.W., Liu, S.Y.
Dietary Branched-Chain Amino Acid Assessment in Broilers from 22 to 35 Days of Age
(2021) *J. Anim. Sci. Biotechnol*, 12, p. 6.

[CrossRef] [PubMed]

- Maynard, C.W., Liu, S.Y., Lee, J.T., Caldas, J.V., Diehl, J.J.E., Rochell, S.J., Kidd, M.T.
Evaluation of Branched-Chain Amino Acids in Male Cobb MV × 500 Broiler Chickens by Using Box-Behnken Response Surface Design
(2021) *Anim. Feed Sci. Technol*, 271, p. 114710.
[CrossRef]

- Clements, J.R.S., Darnell, B.
Myo-Inositol Content of Common Foods: Development of a High-Myo-Inositol Diet
(1980) *Am. J. Clin. Nutr*, 33, pp. 1954-1967.
[CrossRef]

- Gonzalez-uarquin, F., Rodehutscord, M., Huber, K.
Myo-Inositol: Its Metabolism and Potential Implications for Poultry Nutrition— A Review
(2020) *Poult. Sci*, 99, pp. 893-905.
[CrossRef] [PubMed]

- Cowieson, A.J., Zhai, H.X.
Research Note: The Effect of Sequential Displacement of Dietary Dextrose with Myo-Inositol on Broiler Chicken Growth Performance, Bone Characteristics, Ileal Nutrient Digestibility, and Total Tract Nutrient Retention
(2021) *Poult. Sci*, 100, pp. 993-997.
[CrossRef]

- Qaid, M.M., Al-garadi, M.A.
Protein and Amino Acid Metabolism in Poultry during and after Heat Stress: A Review
(2021) *Animals*, 11, p. 1167.
[CrossRef] [PubMed]

Correspondence Address
Selamat J.; Food Safety and Food Integrity (FOSFI), Malaysia; email: jinap@upm.edu.my

Publisher: MDPI

ISSN: 23048158
Language of Original Document: English
Abbreviated Source Title: Foods
2-s2.0-85114986241
Document Type: Article
Publication Stage: Final
Source: Scopus